

Course Curriculum of PG Programme Agriculture

- * *Agronomy*
- * *Agricultural Economics*
- * *Entomology*
- * *Extension Education*
- * *Plant Breeding & Genetics*
- * *Plant Pathology*
- * *Soil Science & Agricultural Chemistry*



**Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
Gwalior–474002 (M.P.)**

COURSE CURRICULUM OF PG PROGRAMME 2015-16

DEPARTMENT OF AGRONOMY

Ist Semester

Code	Course title	Credit
Major Courses		
Agron 501	Modern concepts in crop production	3+0
Agron 504	Principles and practices of water management	2+1
Agron 511	Cropping system and sustainable agriculture	2+0
Agron 512	Dryland Farming and Watershed Management	2+1
Agron 513	Principles & Practices of organic farming	2+1
Minor Courses		
Soils 506	Soil biology and biochemistry	2+1
Soils 510	Remote sensing and GIS techniques for soils and crop studies	
Supporting Courses		
STAT 511	Statistical Methods and applied sciences	3+1
Non Credit Courses		
PGS 501	Library and information services	0+1
PGS 502	Technical writing & communication skills	0+1
PGS 503	Intellectual property its management in Agriculture	1+0

IInd Semester

Major Courses		
Agron 502	Soil fertility and nutrient management	2+1
Agron 503	Principles and practices of weed management	2+1
Agron 512	Dry land farming and watershed management	2+1

Minor Courses			
Soils 502	Soil fertility and fertilizer use		3+1
Soils 509	Soil water and air pollution		2+1
Supporting Courses			
STAT-512	Experimental design		2+1
Non Credit Courses			
PGS 504	Basic concepts in laboratory techniques		0+1
PGS- 505	Agriculture research, Research, ethics and rural development programme		1+0
PGS 506	Disaster management		1+0

IIIrd Semester

Agron 591	Master's Seminar	0+1
Agron 599	Master's Research	0 + 10

IVth Semester

Agron 599	Maser's Research	0+10
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AGRON 501 Modern Concepts in Crop Production 3+0

Objective

To teach the nebasic concepts of soil management and crop production.

Theory

UNIT I

Crop growth analysis in relation to environment; gro-ecological zones of India.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Suggested Readings

Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.

Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.

Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.

- Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

AGRON 502 Soil Fertility and Nutrient Management 2+1

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

UNIT I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT II

Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

- Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils
- Determination of total N, P, K and S in plants
- Interpretation of interaction effects and computation of economic and yield optima

Suggested Readings

- Brady NC & Weil R.R 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

AGRON 503 Principles and Practices of Weed Management 2+1

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

UNIT I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT V

Integrated weed management; cost: benefit analysis of weed management.

Practical

- Identification of important weeds of different crops. Preparation of a weed herbarium
- Weed survey in crops and cropping systems Crop-weed competition studies
- Preparation of spray solutions of herbicides for high and low-volume sprayers
- Use of various types of spray pumps and nozzles and calculation of swath width
- Economics of weed control. Herbicide resistance analysis in plant and soil
- Bioassay of herbicide resistance Calculation of herbicidal requirement

Suggested Readings

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.

- Gupta OP. 2007. *Weed Management – Principles and Practices*. Agrobios.
- Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
- Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.
- Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
- Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 504 Principles and Practices of Water Management 2+1

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

- Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus
- Soil-moisture characteristics curves. Water flow measurements using different devices
- Determination of irrigation requirements. Calculation of irrigation efficiency
- Determination of infiltration rate. Determination of saturated/unsaturated hydraulic conductivity

Suggested Readings

- Lenka D. 1999. *Irrigation and Drainage*. Kalyani
- Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.
- Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.
- Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
- Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
- Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AGRON 511 Cropping Systems and Sustainable Agriculture 2+0

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V

Plant ideo types for dry lands; plant growth regulators and their role in sustainability.

Suggested Readings

- Palaniappan SP & Sivaraman K. 1996. Cropping Systems in the Tropics; Principles and Management. New Age.
- Panda SC. 2003. Cropping and Farming Systems. Agrobios.
- Reddy SR. 2000. Principles of Crop Production. Kalyani.
- Sankaran S & Mudaliar TVS. 1997. Principles of Agronomy. The Bangalore Printing & Publ. Co.
- Singh SS. 2006. Principles and Practices of Agronomy. Kalyani.
- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. Soil Fertility and Fertilizers. Prentice Hall.

AGRON 512 Dryland Farming and Watershed Management 2+1

Objective

To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practical

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Moisture stress effects and recovery behaviour of important crops

- Estimation of moisture index and aridity index
- Spray of anti-transparent and their effect on crops
- Collection and interpretation of data for water balance equations
- Water use efficiency
- Preparation of crop plans for different drought conditions
- Study of field experiments relevant to dryland farming
- Visit to dryland research stations and watershed projects

Suggested Readings

- Das NR. 2007. *Tillage and Crop Production*. Scientific Publishers.
- Dhopote AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.
- Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India*. ICAR.
- Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.
- Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA.
- Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.
- Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publishing Company.
- Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.
- Singh RP. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.
- Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.
- Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

AGRON 513 Principles and Practices of Organic Farming 2+1 Objective

To study the principles and practices of organic farming for sustainable crop production.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost. Making of vermicompost
- Identification and nursery raising of important agro-forestry trees and trees for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field
- Visit to an organic farm

- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

- Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.
- Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.
- Lampin N. 1990. *Organic Farming*. Press Books, Ipswich, UK.
- Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice*. Scientific Publ.
- Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishatana, Bangalore.
- Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
- Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.
- Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.
- SubbaRao NS. 2002. *Soil Microbiology*. Oxford & IBH.
- Trivedi RN. 1993. *A Text Book of Environmental Sciences*, Anmol Publ.
- Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.
- WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*. WHO.
- Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

Note : For minor courses please refer the concerned department's courses outline.

DEPARTMENT OF AGRIL. ECONOMICS & F. M.

Ist Semester

Course No.	Course Title	Credit
Major Courses		
AG. ECON – 501	Micro Economics Theory and Application	2+0
AG. ECON – 502	Macro Economics & Policy	2+0
AG. ECON – 503	Evolution of Economic Thought	1+0
AG. ECON – 504	Agricultural Production Economics	1+1
Minor Courses		
EXT – 502	Development Communication and Information Management	2+1
EXT – 503	Diffusion and Adoption of Innovation	2+1
Supporting Courses		
STAT 511	Statistical Methods for Applied Sciences / Social Science	3+1
Non – Credit Courses		
PGS 501	Library and Information Service	0+1
PGS 502	Technical Writing and Communication Skills	0+1
PGS 503	Intellectual Property and its Management in Agriculture	1+0

IInd Semester

Major Courses		
AG. ECON – 505	Agricultural Marketing & Price Analysis	2+1
AG. ECON – 506	Research Methodology for Social Science	1+1
AG. ECON – 507	Econometrics	2+1
AG. ECON – 508	Linear Programming	1+1
AG. ECON – 509	Agricultural Finance & Project Management	2+1

Minor Courses		
EXT – 506	Entrepreneurships Development and Management in Extension	2+1
EXT – 507	Human Resource Development	2+1
Supporting Courses		
STAT 513	Sampling Techniques	2+1
Non – Credit Courses		
PGS 504	Basic Concept in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programme	1+0
PGS 506	Disaster Management	1+0

IIIrd Semester

Ag. Econ. 591	Master's Seminar	0+1
Ag. Econ. 599	Master's Research	0+10

IVth Semester

Ag. Econ. 599	Master's Research	0+10
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AG ECON 501 Micro Economic Theory and Applications 2+0

Objective

This course is intended to provide an overview of micro economic theory and its applications. The course starts with the theory of consumer behaviour consisting of consumer's utility maximization problem and demand theory. It intends to provide fundamental concepts and models in the theory of production and costs and sets out to provide a basic understanding of price and / or output determination under different types of market structures including factor markets. This course will also expose the students to the theory of general equilibrium and welfare economics.

Theory

UNIT I

Theory of Consumer Behaviour - Cardinal Utility Approach - Ordinal Utility Approach – Income effect and substitution effect – Applications of Indifference curve approach - Revealed Preference Hypothesis – Consumer surplus -Derivation of Demand curve – Elasticity of demand.

UNIT II

Theory of Production - Production functions – Returns to scale and economies of scale – Technical progress – Theory of Costs – Cost curves– Profit maximization and cost minimization – Derivation of supply curve – Law of Supply – Producers' surplus.

UNIT III

Market Equilibrium - Behavior of Firms in Competitive Markets – Perfect Competition - Effect of Taxation and Subsidies on market equilibrium - Monopoly-Monopolistic - Oligopoly- Theory of Factor Markets.

UNIT IV

General Equilibrium Theory - Welfare Economics - Pareto Optimality – Social welfare criteria - Social Welfare functions.

Suggested Readings

- David M Kreps 1990. *A Course in Microeconomic Theory*. Princeton University Press.
- Dewitt KK. 2002. *Modern Economic Theory*. Sultan Chand & Co.
- Henderson JM & Quant RE. 2000. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.
- Koutsoyiannis A. 2003. Modern Microeconomics. The Macmillan Press.
- Silberberg E & Suen W. 2001. *The Structure of Economics— A Mathematical Analysis*.
- McGraw-Hill.Varian Hal R. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AG ECON 502 Macro Economics and Policy 2+0

Objective

Macro economics and Policy course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory, and implication of the macroeconomic policies.

Theory

UNIT I

Nature and Scope of Macro Economics - Methodology and Keynesian Concepts National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.

UNIT II

Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version- Classical theory Vs Keynesian theory – Un employment and Full employment.

UNIT III

Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.

UNIT IV

IS & LM frame work - General Equilibrium of product and money markets -Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy -Central banking.

UNIT V

Business cycles - Balance of Payment - Foreign Exchange Rate determination.

Suggested Readings

- Ahuja HL. 2007. *Macroeconomics: Theory and Policy*. S. Chand & Co.
Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.
Gardner Ackely 1987. *Macro Economic: Theory and Policy*. Collier Macmillan. Dornbusch. 2006. *Macroeconomics*. McGraw Hill Publication

AG ECON 503 Evolution of Economic Thought 1+0

Objective

To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.

Theory

UNIT 1

Approaches for the study of history of economic thought – Absolutist vs. Relativist approaches – Evolution of Economic Thought vs. Economic History. Ancient economic thought – medieval economic thought – mercantilism –physiocracy – Forerunners of Classical Political Economy.

UNIT II

Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) – Critics of Classical Thoughts- Socialist critics –

Socialist and Marxian Economic Ideas – Austrian School of Thought – Origins of Formal Micro economic Analysis – William Stanley Jevons, Cournot and Dupuit.

UNIT III

The birth of neoclassical economic thought – Marshall and Walras – General Equilibrium Theory - Welfare Theory – Keynesian economics.

UNIT IV

The Era of globalization – Experiences of developing world - Rigidity of the pastvs. emerging realism – The changing path of international Institutions to economic growth and development approaches.

UNIT V

Economic Thought in India – Naoroji and Gokhale – Gandhian Economics -Economic thought of independent India – Nehru's economic philosophy -Experiences of the Structural adjustment programmes of the post liberalization era.

Suggested Readings

- Blaug M. 1964. *Economic Theory in Retrospect*. Heineman.
- Blaug M. 1986. *Economic History and the History of Economic Thought*. Wheatsheaf Books, Brighton.
- Ekelund RB & Hebert RF. 1975. *A History of Economic Theory and Methods*. McGraw-Hill.
- John Mills A. 2002. *Critical History of Economics: Missed Opportunities*. Palgrave Macmillan.
- Screpanti E & Zamagni S. 1995. *An Outline of the History of Economic Thought*. Clarendon Press, Oxford.

AG ECON 504 Agricultural Production Economics 1+1

Objective

To expose the students to the concept, significance and uses of agricultural production economics.

Theory

UNIT I

Nature, scope and significance of agricultural production economics- Agricultural Production processes, character and dimensions-spatial, temporal - Centrality of production functions, assumptions of production functions, commonly used forms- Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II

Factors of production, classification, inter dependence, and factor substitution -Determination of optimal levels of production and factor application –Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

UNIT III

Cost functions and cost curves, components, and cost minimization – Duality theory – cost and production functions and its applications - Derivation of firm's input demand and output supply functions - Economies and diseconomies of scale.

UNIT IV

Technology in agricultural production, nature and effects and measurement -Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement -Nature and sources of risk, modeling and coping strategies.

Practical

Different forms of production functions - specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination- optimal product choice- cost function estimation, interpretation-estimation of yield gap -incorporation of technology in production functions- measuring returns to scale risk analysis through linear programming.

Suggested Readings

- Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.
- Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.
- Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*. Vol. I. *Agricultural Production*. Elsevier. Heady EO. *Economics of Agricultural Production and Resource Use*. Prentice-Hall.
- Sankayan PL. 1983. *Introduction to Farm Management*. Tata McGraw Hill.

AG ECON 505 Agricultural Marketing and Price Analysis 2+1

Objective

To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

Theory

UNIT I

Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.

UNIT II

Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -

Performance and Strategies – Market infrastructure needs, performance and Government role - Value Chain Finance.

UNIT III

Role of Information Technology and telecommunication in marketing of agricultural commodities - Market research-Market information service -electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.

UNIT IV

Spatial and temporal price relationship – price forecasting – time series analysis –time series models – spectral analysis. Price policy and economic development –non-price instruments.

UNIT V

Theory of storage - Introduction to Commodities markets and future trading -Basics of commodity futures - Operation Mechanism of Commodity markets –Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis -Role of Government in promoting commodity trading and regulatory measures.

Practical

Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis -quantitative estimation of supply chain efficiency - Market Intelligence –Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports –commodity outlook - Technical Analysis for important agricultural commodities -Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

Suggested Readings

- Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options: Principles and Strategies*. 2nd Ed. Prentice-Hall.
- Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.
- Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.
- Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi.

AG ECON 506 Research Methodology for Social Sciences 1+1 Objective

To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis etc.

Theory

UNIT I

Importance and scope of research in agricultural economics. Types of research -Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

UNIT II

Hypothesis – meaning - characteristics - types of hypothesis – review of literature– setting of Course Objective and hypotheses - testing of hypothesis.

UNIT III

Sampling theory and sampling design – sampling error - methods of sampling –probability and non-probability sampling methods - criteria to choose. Project proposals – contents and scope – different types of projects to meet different needs– trade-off between scope and cost of the study. Research design and techniques –Types of research design.

UNIT IV

Data collection – assessment of data needs – sources of data collection –discussion of different situations. Mailed questionnaire and interview

schedule –structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.

UNIT V

Coding editing – tabulation – validation of data. Tools of analysis – data processing. Interpretation of results – Preparing research report / thesis – Universal procedures for preparation of bibliography – writing of research articles.

Practical

Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose –discussion on sampling under different situations. Scaling Techniques –measurement of scales. Preparation of interview schedule - Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

Suggested Readings

- Black TR. 1993. *Evaluating Social Science Research - An Introduction*. SAGE Publ.
- Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches*. SAGE Publ.
- Dhondyal SP. 1997. *Research Methodology in Social Sciences and Essentials of Thesis Writing*. Amman Publ. House, New Delhi.
- Kothari CR. 2004. *Research Methodology - Methods and Techniques*. Wishwa Prakashan, Chennai.
- Rao KV. 1993. *Research Methodology in Commerce and Management*. Sterling Publ., New Delhi.

Singh AK. 1993. *Tests, Measurements and Research Methods in Behavioural Sciences*. Tata McGraw-Hill.

Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences*. SAGE Publ.

AG ECON 507 Econometrics 2+1

Objective

The Course Objective of the course is to impart knowledge on econometric tools to the students of agricultural economics. Training in econometrics will help the student to analyze the economic problem by applying quantitative techniques.

Theory

UNIT I

Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.

UNIT II

Basic two variable regression - assumptions estimation and interpretation approaches to estimation - OLS, MLE and their properties - extensions to multivariable models-multiple regression estimation and interpretation.

UNIT III

Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification.

UNIT IV

Use of dummy variables-limited dependent variables – specification, estimation and interpretation.

UNIT V

Simultaneous equation models-structural equations - reduced form equations- identification and approaches to estimation.

Practical

Single equation two variable model specification and estimation – hypothesis testing- transformations of functional forms and OLS application-estimation of multiple regression model - hypothesis testing - testing and correcting specification errors - testing and managing Multicollinearity - testing and managing heteroscedasticity - testing and managing autocorrelation - estimation of regressions with dummy variables - estimation of regression with limited dependent variable - identification of equations in simultaneous equation systems.

Suggested Readings

- Gujarati DN. 2003. *Basic Econometrics*. McGraw Hill.
- Johnson AG Jr., Johnson MB & Buse RC. 1990. *Econometrics - Basic and Applied*. MacMillan.
- Kelejian HH & Oates WE. 1994. *Introduction to Econometrics Principles and Applications*. Harper and Row Publ.
- Koutsoyanis A. 1997. *Theory of Econometrics*.
- Barner & Noble. Maddala GS. 1992. *Introduction to Econometrics*. MacMillan.
- Maddala GS. 1997. *Econometrics*. McGraw Hill.
- Pindyck RS & Rubinfeld DL. 1990. *Econometrics Models and Econometric Forecasts*. McGraw Hill.

AG ECON 508 Linear Programming 1+1

Objective

The Course Objective of the course is to impart knowledge of Linear programming techniques.

Theory

UNIT I

Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

UNIT II

Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non farm problems as linear programming models and solutions.

UNIT III

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

UNIT IV

Game Theory- Concepts of game theory, two person constant sum, zero sumgame, saddle point, solution to mixed strategies, the rectangular game as Linear Programme.

Practical

Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

Suggested Readings

Dorfman R. 1996. *Linear Programming & Economic Analysis*. McGraw Hill.

Loomba NP. 2006. *Linear Programming*. Tata McGraw Hill.

Shenoy G. 1989. *Linear Programming-Principles & Applications*. Wiley Eastern Publ.

Vaserstein. 2006. *Introduction to Linear Programming*. Pearson Education Publication

AG ECON 509 Agricultural Finance and Project Management 2+1

Objective

The Course Objective of the course is to impart knowledge on issues related to lending to priority sector credit management and financial risk management. The course would bring in the various appraisal techniques in project - investment of agricultural projects.

Theory

UNIT I

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing -Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

UNIT V

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications.

Practical

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme-Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

Suggested Readings

- Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India*. Sage Publ.
- Gittinger JP 1982. *Economic Analysis of Agricultural Projects*. The Johns Hopkins Univ. Press.
- Gupta SC. 1987. *Development Banking for Rural Development*. Deep & Deep Publ.
- Little IMD & Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries*. Oxford & IBH Publ.
- Muniraj R. 1987. *Farm Finance for Development*. Oxford & IBH Publ.

Note: For minor courses please refer the concerned department's courses outline.

DEPARTMENT OF PLANT BREEDING & GENETICS

Ist Semester

Course no.	Course Title	Credits
Major Courses		
GP501	Principles of Genetics	2+1
GP502	Principles of Cytogenetic	2+1
GP503	Principles of Plant breeding	2+1
GP508	Cell Biology and Molecular genetics	2+1
Minor Courses		
Pl.Path 505	Detection & diagnosis of plant diseases	0+2
Pl.Path 513	Disease resistance in plants	2+0
Supporting		04
STAT511	Statistical methods for applied Sciences	3+1
Non-credit Courses		
PGS501	Library &Information Services	0+1
PGS502	Technical Writing & Communication Skill	0+1
PGS503	Intellectual property& Its management in Agriculture	1+0

IInd Semester

Major Courses		
GP504	Principles of Quantitative Genetics	2+1
GP509	Bio Technology for Crop Improvements	2+1
GP515	Maintenance Breeding and concept of Variety release and seed production	1+1

Minor Courses		
ENT 511	Pest of Field crops	1+1
Pl. Path 516	Integrated disease management	2+1

Supporting Courses		
STAT512	Design of Experiments	2+1
Non-credit courses		
PGS504	Basic Concept in Laboratory Technique	0+1
PGS505	Agricultural Research, Research Ethics and Rural development program	1+0
PGS506	Disaster Management	1+0

IIIrd Semester

GP591	Master Seminar	0+1
GP599	Masters Research	0+10

IVth Semester

GP599	Masters Research	0+10
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GP 501 Principles of Genetics 2+1

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

UNIT II

Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

UNIT III

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT IV

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

UNIT V

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT VI

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and

transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

UNIT VII

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT VIII

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT IX

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.

UNIT X

Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Practical

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes – use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

Suggested Readings

Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.

Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

- Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.
- Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.
- Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India
- Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.
- Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

GP 502 Principles of Cytogenetics 2+1

Objective

To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

UNIT I

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II

Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications.

UNIT III

Structural and Numerical variations of chromosomes and their implications- Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids; Utilization of an euploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction; Evolutionary

significance of chromosomal aberrations - balanced lethals and chromosome complexes.

UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids Vegetable Science allopolyploids -- Role of euploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with a pomixes.

UNIT V

Reversion of auto polyploids to diploids; Genome mapping in polyploids – Inter specific hybridization and allopolyploids; Synthesis of new crops(wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

UNIT VI

Fertilization barriers in crop plants at pre-and post fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera*- Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation

of temporary and permanent slides - Pollen germination *in vivo* and *in vitro*; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level -Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on lloployploids - Morphological observations on an euploids- Cytogenetic analysis of inter specific and intergeneric crosses -Maintenance of Cytogenetic stocks and their importance in crop breeding -Various ploidy levels due to somaclonal variation ; Polyploidy inornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *insitu* hybridization GISH.

Suggested Readings

- Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.
- Carroll M. 1989. *Organelles*. The Guilford Press.
- Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall.
- Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen &Unwin Ltd.
- Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.
- Gray P. 1954. *The Mirotomist'sFormulatory Guide*. The Blakiston Co.
- Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A. Elsevier.
- Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.
- Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.
- Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
- Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.
- Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth.
- Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
- Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

GP 503 Principles of Plant Breeding 2+1

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

UNIT II

Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

UNIT III

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT IV

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of

heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

UNIT VI

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

UNIT VII

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT VIII

Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.

Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.

Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.

Gupta SK. 2005. *Practical Plant Breeding*. Agribios.

Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.

- Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.
- Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
- Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.
- Singh BD. 2006. *Plant Breeding*. Kalyani.
- Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.
- Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.
- Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*.

GP 504 Principles of Quantitative Genetics 2+1

Objective

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Theory

UNIT I

Mendelian traits vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function

and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis- principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendograms -interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II –Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression -Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions -Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis

and Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model – Principal Component Analysis model - Additive and multiplicative model – Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

Suggested Readings

- Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
- Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.
- Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
- Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
- Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
- Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.
- Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.
- Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 508 Cell Biology and Molecular Genetics 2+1

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Theory

UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloro/chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II

Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division.

UNIT III

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cellaging.

Practical

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaqueassay method; Determination of soluble protein content in a bacterialculture.

Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

Suggested Readings

- Bruce A. 2004. *Essential Cell Biology*. Garland.
- Karp G. 2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.
- Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.
- Lewin B. 2008. *IX Genes*. John Wiley & Sons
- Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.
- Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.
- Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.
- Schleif R. 1986. *Genetics and Molecular Biology*. Addison - Wesley Publ. Co.

GP 509 Biotechnology for Crop Improvement 2+1

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic

hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT IV

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Genepyramiding.

UNIT V

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major

countries including India, ethical, legal and social issues; Intellectual property rights

UNIT IX

Bioinformatics & Bioinformatics tools.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media –interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gelectrophoresis of proteins and isozymes, PCR-based DNA markers, gelscoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation*. 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning - a Laboratory Manual*. 3rd Ed. Cold Spring Harbor Lab. Press.

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani

GP 515 Maintenance Breeding and Concepts of Variety Release and Seed Production 1+1

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties – safe guards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

Suggested Readings

- Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
- Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Department of Plant Breeding. CCS HAU Hisar.
- Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.
- McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
- Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC.
- Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops*. Oxford & IBH.
- Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
- Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.
- Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

Note: For minor courses please refer the concerned department's courses outline

DEPARTMENT OF ENTOMOLOGY

Ist Semester

Course No.	Courses Title	Credit
Major Courses		
ENT 501	Insect Morphology	1+1
ENT 504	Classification of Insects	2+1
ENT 510	Principles of Integrated Pest Management	1+1
ENT 518	Techniques in Plant Protection	0+1
Minor Courses		
Pl. Path 505	Detection and diagnosis of Plant Diseases	0+2
Pl. Path 513	Disease resistance in Plant Diseases	2+0
Supporting Courses		
STAT 511	Statistics Methods	3+1
Non Credit Courses		
PGS 501	Library and information services	0+1
PGS 502	Technical writing and communication skills	0+1
PGS 503	Intellectual property and its Management in Agriculture	0+1

IInd Semester

ENT 502	Insect Anatomy, Physiology and Nutrition	2+1
ENT 505	Insect Ecology	1+1
ENT 507	Biological control of crop pests and weeds	1+1
ENT 508	Toxicology of Insecticides	2+1
ENT 511	Pests of field crops	1+1

Minor Courses		
Pl. Path 503	Plant Bacteriology	2+1
Pl. Path 516	Integrated Disease management	2+1
Supporting Courses		
STAT 512	Design of Experiments	2+1
Non-Credit Courses		
PGS 504	Basic concepts in laboratory Techniques	0+1
PGS 505	Agriculture Research Ethics	1+0
PGS 506	Disaster Management	1+0

IIIrd Semester

ENT 591	Master's Seminar	0+1
ENT599	Master's Research	0+10

IVth Semester

ENT599	Master's Research	0+10
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ENT 501 Insect Morphology 1+1

Objective

To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.

Theory

Unit I

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

Unit II

Head- Origin, structure and modification; types of mouth parts and antennae, tentorium and neck sclerites.

Unit III

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.

Unit IV

Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano- photo- and chemoreceptors).

Practical

Study of insect segmentation, various stigmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

Suggested Readings

Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.

David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata-McGraw Hill, New Delhi.

- Dunston PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
- Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.
- Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
- Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ. Academy, Jodhpur.
- Snodgross RF. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.

ENT 502 Insect Anatomy, Physiology and Nutrition 2+1

Objective

To impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology, nutritional physiology and their application in entomology.

Theory

Unit I

Scope and importance of insect anatomy and physiology.

Unit II

Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

Unit III

Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause.

Unit IV

Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

Practical

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free aminoacids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Suggested Readings

- Chapman RF. 1998. *Insects: Structure and Function*. ELBS Ed., London.
- Dunton PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
- Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, New York.
- Patnaik BD. 2002. *Physiology of Insects*. Dominant, New Delhi.
- Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Vol.1. *Structure, Physiology and Development*. Chapman & Hall, New York.
- Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.
- Wigglesworth VB. 1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York.

ENT 504 Classification of Insects 2+1

Objective

To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Theory

Unit I

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.

Unit II

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera): Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera, Subdivision: Hemipteroid Orders (Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

Unit III

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

Collection and preservation of insects. Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

Suggested Readings

- CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols.I & II, CSIRO. Cornell Univ. Press, Ithaca.
- Freeman S & Herron JC. 1998. *Evolutionary Analysis.* Prentice Hall, New Delhi.
- Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London. Vol 2.
- Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co.
- Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.* 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

ENT 505 Insect Ecology 1+1

Objective

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study of life tables, organization of communities, diversity indices. Train students in sampling methodology, calculation of diversity indices, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

Unit I

History and Definition. Basic Concepts. Organisation of the Biological world. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

Unit II

Basic concepts of abundance- Model vs Real world. Population growth basic models –Exponential vs Logistic models. Discrete vs Continuous growth models. Balance of life innature- Concepts of Carrying capacity, Environmental Resistance. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

Unit III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions – The argument of cost benefit ratios. Competition- Lotka-Volterra model, Concept of niche, ecological homologues, competitive exclusion. Prey-predator interactions- Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

Unit IV

Community ecology- Concept of guild, Organisation of communities. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity stability debate, relevance to pest management. Pest management as applied ecology.

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic

representation of niches of organisms. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

Suggested Readings

- Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2nd Ed. Cambridge Univ. Press, Cambridge.
- Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Inc., Sunderland, MA.
- Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios, Jodhpur.
- Krebs CJ. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
- Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.
- Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton Univ. Press, Princeton.
- Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.
- Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: Classic Papers with Commentaries*. University of Chicago Press, Chicago.
- Southwood TRE & Henderson PA. 2000. *Ecological Methods*. 3rd Ed. Methuen & Co. Ltd., London.
- Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.
- Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University, USA.
- Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold, London.

ENT 507 Biological Control of Crop Pests and Weeds 1+1

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Theory

Unit I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

Unit II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

Unit III

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

Unit IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Suggested Readings

- Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites*. Academic Press, London.
- De Bach P. 1964. *Biological Control of Insect Pests and Weeds*. Chapman & Hall, New York.
- Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches*. Kalyani Publ., New Delhi.
- Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.
- Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control*. Academic Press, London.
- Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.
- Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.
- Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman & Hall, New York.

ENT 508 Toxicology of Insecticides 2+1

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of

organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrazoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

Unit IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning. Sprayers, dusters and other plant protection appliances.

Practical

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances: Principles, operation and maintenance. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

Suggested Readings

Chattopadhyay SB. 1985. *Principles and Procedures of Plant Protection.* Oxford & IBH, New Delhi.

Gupta HCL. 1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

- Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action*. Narosa Publ. House, New Delhi.
- Matsumura F. 1985. *Toxicology of Insecticides*. Plenum Press, New York.
- Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment*. Narosa Publ. House, New Delhi.
- Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture*. Lewis Publ., New York.

ENT 510 Principles of Integrated Pest Management 1+1

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

Theory

Unit I

History and origin, scope and need for IPM, definition and evolution of various related terminologies.

Unit II

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

Unit III

Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practical

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses,

unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Visit to IPM fields.

Suggested Readings

- Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches*. Kalyani Publ., New Delhi.
- Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
- Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. 1st Ed., Springer, New York.
- Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer, New Delhi.
- Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.
- Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
- Pedigo RL. 2002. *Entomology and Pest Management*. 4th Ed. Prentice Hall, New Delhi.
- Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management*. Prentice Hall, New Delhi.
- Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products*. Marcel Dekker, New York.

ENT 511 Pests of Field Crops 1+1

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

Unit I

Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).

Unit II

Insect pests of pulses, tobacco, oilseeds and their management.

Unit III

Insect pests of fibre crops, forages, sugarcane and their management.

Practical

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

Suggested Readings

Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology*. Popular Book Depot, Chennai.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.

Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi

Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.

Nair MRGK. 1986. *Insect and Mites of Crops in India*. ICAR, New Delhi.

Prakash I & Mathur RP. 1987. *Management of Rodent Pests*. ICAR, New Delhi.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.

ENT 518 Techniques in Plant Protection 0+1

Objective

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopy, computation, pest forecasting, electrophoresis etc.

Unit I

Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, soaking, root-dip treatment, dusting, spraying, application through irrigation water.

Unit II

Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cutting and cut flower.

Unit III

Use of light transmission and scanning electron microscopy.

Unit IV

Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE .27

Unit V

Use of tissue culture techniques in plant protection.Computer application for predicting/forecasting pest attack and identification.

Suggested Reading

Alford DV. 1999. A *Text book of Agriculture Entomology*. Blackwell Science, London

Cramton JM & Eggleston P.1992. *Insect Molecular Science*. Academic press, London.

Note: For minor courses please refer the concerned department's courses outline.

DEPARTMENT OF EXTENSION EDUCATION

Ist Semester

Course No.	Course Title	Credit
Major Courses		
EXT 501	Development Perspectives of Extension Education	1+1
EXT 502	Development Communication and Information Management	2+1
EXT 503	Diffusion and Adoption of Innovations	2+1
EXT 504	Research Methods in Behavioral Sciences	2+1
Minor Courses		
AG. EONO 503	Evolution of Economic Thought	1+0
AG. EONO 504	Agriculture Production Economics	1+1
Supporting Courses		
STAT 511	Statistical Methods for Applied Sciences / Social Science	3+1
Non – Credit Courses		
PGS 501	Library and Information Service	0+1
PGS 502	Technical Writing and Communication Skills	0+1
PGS 503	Intellectual Property and its Management in Agriculture	1+0

IInd Semester

Major Courses		
EXT 505	e-Extension	2+1
EXT 506	Entrepreneurship Development and Management in Extension	2+1
EXT – 507	Human Resource Development	2+1
Minor Courses		
AG. ECON – 505	Agricultural Marketing & Price Analysis	2+1
AG. ECON – 509	Agricultural Finance & Project Management	2+1
Supporting Courses		
STAT 513	Sampling Techniques	2+1
Non – Credit Courses		
PGS 504	Basic Concept in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programme	1+0
PGS 506	Disaster Management	1+0

IIIrd Semester

Ag. Econ.591	Master's Seminar	0+1
Ag. Econ. 599	Master's Research	0+10
IVth Semester		
Ag. Econ. 599	Master's Research	0+10

DEPARTMENT OF EXTENSION EDUCATION

EXT 501 Development Perspectives of Extension Education (1+1)

Theory

UNIT I

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension, Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centers, and NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

Suggested Readings

- Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. *Extension Education What? And What Not?* RBSA Publ.
- Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Processbased on Non-Formal Education Methods.* Global EPM Facility, FAO.
- Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education.* Associated Publishing Co.
- Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ.
- Khan PM. 2002. *Textbook of Extension Education.* Himalaya Publ.
- Ray GL. 2006. *Extension Communication and Management.* Kalyani Publ.
- Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension.* 2nd Ed. CBS.
- Viswanathan M. 1994. *Women in Agriculture and Rural Development.* Printwell Publ.

EXT 502: Development Communication and Information Management 2+1

Theory

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT II

Methods of communication: Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, Interpersonal communication, Organizational communication, Key communicators– Meaning, characteristics and their role in development.

UNIT III

Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People, Modern communication media– Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV

Agricultural Journalism as a means of mass communication, its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders, Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

Practical

Identification of characteristics of key communicators of villages, practical ways to improve oral presentation skill, preparation of bulletins and folders, scripting writing for newspapers, magazine, articles, radio and television. Preparation of Tele conferencing. Study of Barriers in Communication. Study the role of mass media & media mix in dissemination of Agricultural technology

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development*. Oxford & IBH.

- Grover, I; Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agrotech Publ. Academy.
- Jana BL & Mitra KP. 2005. *Farm Journalism*. Agrotech Publ. Academy
- Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.
- Rayudu CS. 2002. *Communication*. Himalaya Publ. House
- Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.
- Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods*. Oxford & IBH

EXT 503 Diffusion and Adoption of Innovations 2+1

Theory:

UNIT I

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation - development process; tracing the innovation-development process, converting research into practice.

UNIT II

The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation

UNIT III

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV

Diffusion effect and concept of over adoption, opinion leadership-measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophile and heterophily and their influence on flow of innovations;

Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation - Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

Practical

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Suggested Readings

- Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.
- Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ. Co
- Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.
- Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.
- Rogers, E.M. 2003. Diffusion of Innovations.5th Ed. The Free Press, New York.

EXT 504 Research Methods in Behavioural Sciences 2+1

Theory

UNIT I

Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research, Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation,

Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, planning the review work, Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.

UNIT II

Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling- Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maxi-Min- Con Principle, Sampling – Types of sampling and sampling procedures.

UNIT III

Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design, Experimental design – Advantages and limitations, Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires–Meaning, difference between schedule and question-

naire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales– Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use, Case studies – Meaning, types, steps in conducting, advantages and limitations in its use, Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.

UNIT IV

Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, references in reporting

Practical

Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.- Testing the validity and reliability of the data collection instruments: Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research, writing report, writing of thesis and research articles-presentation of reports.

Suggested Readings

- Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research*. APH Publ.
- Kerlinger FN. 1973. *Foundations of Behavioural Research*. Holt Rhinehart.

- Kothari CR. 1984. *Research Methodology, Methods and Techniques*. Chaitanya Publ. House.
- Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences*. Himalaya Publ. House.
- Mulay S & Sabaratnam VE. 1983. *Research Methods in Extension Education*. Manasavan.
- Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.
- Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.
- Wilkinson TS & Bhandarkar PC. 1993. *Methodology and Techniques of Social Research*. Himalaya Publ. Home.

EXT 505 e- Extension 2+1

Theory

UNIT I

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities

UNIT II

ICTs projects, case studies in India and developing world. Different approaches

(Models) to ICTs, ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video Conferencing, Computer Aided Extension, Knowledge management, Information kiosks,

Multimedia, Online, Offline Extension, Tools-Mobile technologies, e-learning concepts

UNIT IV

ICT Extension: approaches-pre-requisites, information and science needs of farming community, Need integration, Human resource information, Intermediaries. Basic e-extension training issues, ICT enabled extension pluralism, emerging issues in ICT.

Practical

Agril. Content Analysis of ICT Projects, Handling of ICT tools, Designing extension content, online extension service, and project work on ICT enabled extension, Creation of extension blogs, Visit to ICT extension projects.

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development- Cases from India*. Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*. Ganga- Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information – A Guide to Information Technology*. The World Bank, Washington.

EXT 506 Entrepreneurship Development and Management in Extension (2+1)

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development, Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making,

Planning, Organizing, Coordinating and Marketing, Types of Entrepreneurs Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries, Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination: Concept, Need, Types, Techniques of Coordination, Interpersonal relations in the organization, Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles, Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication, Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision –Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision, Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions- Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making- Designing organizational structure -Group activity on leadership development skills.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.

Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.

Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.

Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.

Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.

Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

EXT 507 Human Resource Development 2+1

Theory

UNIT I

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

UNIT II

Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Skills required for Extension workers; Decision Making: Decision making models, Management by Objectives; Behavioral Dynamics: Leadership styles – Group dynamics.

UNIT III

Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation, Facilities for training – Trainers training – techniques for trainees' participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

Practical

Visit to different training organizations to review ongoing activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees' welfare and improving quality of work life and Human resource information, Presentation of reports.

Suggested Readings

- Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.
- David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.
- Davis Keth & Newston W John 1989. *Human Behaviour at Work*. 8th Ed. McGraw-Hill.
- Hersey Paul & Balanchard H Kenneth. 1992. *Management of Organizational Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.
- Knoontz Harold & Weihrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.
- Lynton RP & Pareek U. 1993. *Training for Development*. DB. Taraporewale Sons & Co.
- Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*. Kalyani Publ.

- Rao TV. 2003. *Readings in Human Resource Development*. Oxford Publ. Co.
- Silberman Mel. 1995. *Active Training*. Press Johnston Publ. Co., New Delhi.
- Singh RP. 2000. *Management of Training Programmes*. Anmol Publ.
- Subba Rao P. 2005. *Management & Organizational Behaviour*. Himalaya Publ. House.
- Sundaram RM, Gupta V, George SS. 2006. *Case Studies in Human Resource Management*. ICFAI, Hyderabad.
- Tripati & Reddy. 2004. *Principles of Management*. Tata McGraw-Hill.
- Wayne MR & Robert MN. 2005. *Human Resource Management*. International Ed. Pearson Prentice Hall.

Note : For minor courses please refer the concerned department's courses outline.

DEPARTMENT OF PLANT PATHOLOGY

Ist Semester

CODE	COURSE TITLE	CREDITS
Major Courses		
PL PATH 501	Mycology	2+1
PL PATH 502	Plant Virology	2+1
PL PATH 504	Principles of Plant Pathology	3+0
PL PATH 505	Detection and Diagnosis of Plant Diseases	0+2
PL PATH 513	Disease Resistance in Plants	2+0
Minor Courses		
ENT 504	Classification of Insects	2+1
ENT 510	Principles of int. Pest Management	1+1
Supporting Courses		
STAT 511	Statistical Methods	2+1
Non-Credit Courses		
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skills	0+1
PGS 503	Intellectual Property and its Management in Agriculture	1+0

IInd Semester

Major Courses		
PL PATH 503	Plant Bacteriology	2+1
IPL PATH 510	Seed Health Technology	2+1
PL PATH 516	Integrated Disease Management	2+1

NEMA 510	Nematode Management	2+1
Minor Courses		
ENT 507	Biological Control of Crop Pests and Weeds	1+1
ENT 511	Pests of Field Crops	1+1
Supporting Courses		
STAT 512	Design of Experiments	2+1
Non-Credit Courses		
PGS 504	Basic Concepts in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	Disaster Management	1+0

IIIrd Semester

PL PATH 591	Master's Seminar	0+1
PL PATH 599	Master's Research	0+10

IVth Semester

PL PATH 599	Master's Research	0+10
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PL PATH 501 Mycology 2+1

Objective

To study the nomenclature, classification and characters of fungi.

Theory

UNIT I

Introduction, definition of different terms, basic concepts.

UNIT II

Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.

UNIT III

Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

UNIT IV

The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota-i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi.

Practical

Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Isolation and identification of plant pathogenic fungi.

Suggested Readings

Ainsworth GC, Sparrow FK & Susman HS. 1973. *The Fungi – An Advanced Treatise*. Vol. IV (A & B). Academic Press, New York.

Alexopoulos CJ, Mims CW & Blackwell M. 2000. *Introductory Mycology*. 5th Ed. John Wiley & Sons, New York.

Mehrotra RS & Arneja KR. 1990. *An Introductory Mycology*. Wiley Eastern, New Delhi.

Sarbhoy AK. 2000. *Text book of Mycology*. ICAR, New Delhi.

Singh RS. 1982. *Plant Pathogens—The Fungi*. Oxford & IBH, New Delhi.

Webster J. 1980. *Introduction to Fungi*. 2nd Ed. Cambridge Univ. Press, Cambridge, New York.

PL PATH 502 Plant Virology 2+1

Objective

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Theory

UNIT I

History of plant viruses, composition and structure of viruses.

UNIT II

Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship.

UNIT III

Virus nomenclature and classification, genome organization, replication and movement of viruses.

UNIT IV

Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

UNIT V

Mycoviruses, phytoplasmaarbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome.

UNIT VI

Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical

Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy and ultratometry, PCR.

Suggested Readings

- Bos L. 1964. *Symptoms of Virus Diseases in Plants*. Oxford & IBH., New Delhi.
- Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. *Virus of Plants: Descriptions and Lists from VIDE Database*. CABI, Wallington.
- Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.
- Hull R. 2002. *Mathew's Plant Virology*. 4th Ed. Academic Press, New York.
- Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Oxford & IBH, New Delhi.

PL PATH 503 PlantBacteriology 2+1

Objective

To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Theory

UNIT I

History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria.

UNIT II

Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.

UNIT III

Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya.

UNIT IV

General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT V

Prokaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT VI

Survival and dissemination of phytopathogenic bacteria.

Practical

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics.

Suggested Readings

Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.

Jayaraman J & Verma JP. 2002. *Fundamentals of Plant Bacteriology*. Kalyani Publ., Ludhiana.

Mount MS & Lacy GH. 1982. *Phytopathogenic Prokaryotes*. Vols.I, II. Academic Press, New York.

Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.

Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.

PL PATH 504 Principles of Plant Pathology 3+0

Objective

To introduce the subject of Plant Pathology, its concepts and principles.

Theory

UNIT I

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

UNIT II

Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

UNIT III

Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

UNIT IV

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

UNIT V

Disease management strategies.

Suggested Readings

- Agrios GN. 2005. *Plant Pathology*. 5th Ed. Academic Press, New York.
- Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.
- Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH, New Delhi.
- Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.
- Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*. Oxford & IBH, New Delhi.

Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH, New Delhi.

PL PATH 505 Detection and Diagnosis of Plant Diseases 0+2

Objective:

To impart training on various methods/techniques/instruments used in the study of plant diseases/pathogens.

Practical

UNIT I

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

UNIT II

Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

UNIT III

Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

Suggested Readings

Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. *Laboratory Exercises in Plant Pathology: An Instructional Kit*. Scientific Publ., Jodhpur.

Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.

Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABI Wallington.

- Mathews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Boca Raton, Tokyo.
- Pathak VN. 1984. *Laboratory Manual of Plant Pathology*. Oxford & IBH, New Delhi.
- Forster D & Taylor SC. 1998. *Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology*. Humana Press, Totowa, New Jersey.
- Matthews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Florida.
- Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Cent. Agic. Pub. Doc. Wageningen.
- Trigiano RN, Windham MT & Windham AS. 2004. *Plant Pathology- Concepts and Laboratory Exercises*. CRC Press, Florida.
- Chakravarti BP. 2005. *Methods of Bacterial Plant Pathology*. Agrotech, Udaipur.

PL PATH 510 Seed Health Technology 2+1

Objective

To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/loses and management.

Theory

UNIT I

History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II

Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III

Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV

Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical

Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

Suggested Readings

Agarwal VK & JB Sinclair. 1993. *Principles of Seed Pathology*. Vols.I & II, CBS Publ., New Delhi.

Hutchins JD & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, Wallington.

Paul Neergaard. 1988. *Seed Pathology*. MacMillan, London.

Suryanarayana D. 1978. *Seed Pathology*. Vikash Publ., New Delhi.

PL PATH 513 Disease Resistance in Plants 2+0

Objective

To acquaint with disease resistance mechanisms in plants.

Theory

UNIT I

Introduction and historical development, dynamics of pathogen city, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

UNIT II

Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT III

Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT IV

Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

Suggested Readings

- Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge, New York.
- Mills Dalliceet al.1996. *Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction*. APS, St Paul, Minnesota.
- Parker J. 2008. *Molecular Aspects of Plant Diseases Resistance*. Blackwell Publ.
- Robinson RA. 1976. *Plant Pathosystems*. Springer Verlag, New York.
- Singh BD. 2005. *Plant Breeding – Principles and Methods*. 7th Ed. Kalyani Publ., Ludhiana
- Van der Plank JE. 1975. *Principles of Plant Infection*. Academic Press, New York.
- Van der Plank JE. 1978. *Genetic and Molecular Basis of Plant Pathogenesis*. Springer Verlag. New York.
- Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press, New York.
- Van der Plank JE. 1984. *Disease Resistance in Plants*. Academic Press, New York.

PL PATH 516 Integrated Disease Management 2+1

Objective

To emphasize the importance and need of IDM in the management of diseases of important crops.

Theory

UNIT I

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

UNIT II

Development of IDM- basic principles, biological, chemical and cultural disease management.

UNIT III

IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed , mustard, pearl millet, *kharif* pulses, vegetable crops and fruit crops.

Practical

Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi. 78

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

NEMA 510 Nematode Management 2+1

Objective

To impart comprehensive knowledge about the principles and practices of nematode management.

Theory

UNIT I

Concepts and history of nematode management; crop loss estimation, ecological and socio-economic aspects, cost-benefit ratios and pest risk analysis.

UNIT II

Chemical methods- nematicides, their types, classification, mode of action, applicators and application methods, antidotes, and economizing nematicidal use.

UNIT III

Cultural practices- crop rotations and cropping sequences, fallowing, flooding, soil solarisation, time of sowing, organic amendments of soil, biofumigation, antagonistic and trap crops, sanitation etc. Physical methods- use of heat, hot water treatment and other methods of disinfestations of planting material.

UNIT IV

Biological methods- concepts and terminology, use of predators and parasites as biological control agents, their mass multiplication and field use; phytotherapeutic methods – use of antagonistic plants and antinemic plant products.

UNIT V

Genetic methods- plant resistance; legal methods- quarantine regulations; integrated nematode management- concepts and applications.

Practical

In vitro screening of synthetic chemicals and plant products for nematicidal activity, and their application methods; methods for screening of crop germplasm for resistance against nematodes,

laboratory exercises on biocontrol potential of fungal, bacterial parasites, and predacious fungi and nematodes.

Suggested Readings

- Bhatti DS & Walia RK. 1994. *Nematode Pest Management in Crops*. CBS, New Delhi.
- Brown GL. 1977. *The Nematode Destroying Fungi*. CBP, Guelph.
- Brown RH & Kerry BR. 1987. *Principles and Practice of Nematode Control in Crops*. Academic Press, Sydney.
- Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. II: Nematode Management and Utilization*. CABI, Wallingford.
- Perry RN & Moens M. 2006. *Plant Nematology*. CABI, Wallingford.
- Starr JL, Cook R & Bridge J. 2002. *Plant Resistance to Parasitic Nematodes*. CABI, Wallingford.
- Whitehead AG. 1997. *Plant Nematode Control*. CABI, Wallingford. 55

Note : For minor courses please refer the concerned department's courses outline

DEPARTMENT OF SOIL SCIENCE & AGRICULTURAL CHEMISTRY

Ist Semester

COURSE NO.	NAME OF COURSE	CREDITS
Major Courses		
SOILS 503	Soil Chemistry	2+1
SOILS 504	Soil Mineralogy, Genesis, Classification and Survey	2+1
SOILS 506	Soil Biology and Biochemistry	2+1
SOILS 510	Remote Sensing and GIS Techniques for Soil and Crop Studies	2+1
Minor Courses		
Agron 504	Principles and Practices of Water Management	2+1
Agron 513	Principles and Practices of Organic Farming	2+1
Supporting Courses		
STAT 511	Statistical Methods	2+1
Non-Credit Courses		
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skills	0+1
PGS 503	Intellectual Property and its Management in Agriculture	1+0

IInd Semester

Major Courses		
SOILS 501	Soil Physics	2+1
SOILS 502	Soil Fertility and Fertilizer use	3+1
SOILS 509	Soil Water and Air Pollution	2+1
Minor Courses		
Agron 502	Principles and Practices of Soil Fertility	2+1
Agron 512	Dry Land Farming	2+1
Supporting Courses		
STAT 512	Design of Experiments	2+1
Non-Credit Courses		
PGS 504	Basic Concepts in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	Disaster Management	1+0

IIIrd Semester

Soil 591	Master's Seminar	0+1
Soil 599	Master's Research	0+10
IVth Semester		
Soil 599	Master's Research	0+10

SOILS 503 Soil Chemistry 2+1

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

UNIT I

Chemical (elemental) composition of the earth's crust and soils.

UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

UNIT IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI

Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII

Chemistry of salt-affected soils and amendments; soil pH, EC_e, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E₄/E₆) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E₄/E₆) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simpleadsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/ sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by BaCl₂-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil*. Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

- Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.
- McBride MB. 1994. *Environmental Chemistry of Soils*. Oxford Univ. Press.
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- Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.
- Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
- Van Olphen H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 504 Soil Mineralogy, Genesis, Classification and Survey 2+1 Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT I

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

UNIT II

Classification, structure, chemical composition and properties of clayminerals; genesis and transformation of crystalline and non-crystalline clayminerals; identification techniques; amorphous soil constituents and other on-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT III

Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soilmaps – usefulness.

UNIT V

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes inthe framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
- Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
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- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- USDA. 1999. *Soil Taxonomy*. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
- Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.
- Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy: II. The Soil Orders*. Elsevier.
- Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy. I. Concept and Interaction*. Elsevier.

SOILS 506 Soil Biology and Biochemistry 2+1

Objective

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.

UNIT IV

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI

Biofertilizers – definition, classification, specifications, method of production and role in crop production.

Practical

- Determination of soil microbial population Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N₂ fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.

Burges A & Raw F. 1967. *Soil Biology*. Academic Press.

- McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
- Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.
- Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
- Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
- Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill. 92
- Stotzky G & Bollag JM. 1993. *Soil Biochemistry*. Vol. VIII. Marcel Dekker.
- Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
- Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SOILS 510 Remote Sensing and GIS Techniques for Soil, Water and Crop Studies 2+1

Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to rigging, and GIS and applications in agriculture.

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT IV

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT V

Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of and resources
- Analysis of variability of different soil properties with classical and geostatistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.
- Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.
- Nielsen DR & Wendoroth O. 2003. *Spatial and Temporal Statistics*. Catena Verloggmbh.
- Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

SOILS 502 Principle and Practices of Soil Fertility 3+1

Objective

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

UNIT I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.

UNIT II

Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

UNIT III

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT IV

Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V

Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT VI

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT VII

Common soil test methods for fertilizer recommendations; quantity–intensity relationships; soil test crop response correlations and response functions.

UNIT VIII

Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

UNIT IX

Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical

- Principles of colorimetry
- Flame-photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.
- Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
- Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.
- Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
- Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
- Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality*. 2nd Ed. CRC Press.
- Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers*. 5th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SOILS 501 Soil Physics 2+1

Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

UNIT IV

Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

UNIT V

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

UNIT VI

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity,

hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT VII

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

UNIT IX

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT X

Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of soil-moisture characteristics curve and computation of pore-size distribution
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

Suggested Readings

Bauer LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.
Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

- Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.
- Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
- Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.
- Hillel D. 1998. *Environmental Soil Physics*. Academic Press.
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- Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
- Kohnke H. 1968. *Soil Physics*. McGraw Hill.
- Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
- Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SOILS 509 Soil, Water and Air Pollution 2+1

Objective

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides – their classification, behavior in soil and effect on soil microorganisms.

UNIT V

Toxic elements—their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases—carbon dioxide, methane & nitrous oxide.

UNIT VIII

Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents
- Heavy metals in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect*. CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience. Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.

Note : For minor courses please refer the concerned department's courses outline.